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Switching to the Inflation Targeting Regime: Does it necessary for the case of Egypt?

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Abstract:
The purpose of this paper is to answer the question of whether the switching to the Inflation Targeting (IT) regime is necessary for the Egyptian case or not? Our judgment of applying IT regime in the Egyptian economy is established on doubled criterion. That is, the practical experience of the inflation targeters, and the efficiency of Monetary Targeting Regime (MTR) in the case of Egypt. Defining the efficiency of a monetary policy regime by the efficiency of the embedded nominal anchor to send the right message to all practitioners about the potential behavior of the price level, I assessed the efficiency of MTR in Egypt by measuring; whether there is a relationship between money and prices, the stability of the velocity of circulation, and the stability of the demand for money function. The study concluded that MTR is not efficient to tie down individuals expectations about the future path of inflation in Egypt. Taking into account that IT regime is a way to reform monetary policy and it does not worsen economic performance it becomes necessary for Egypt to switch to the IT regime once the prerequisites for IT regime have been met.

Keywords: inflation targeting; demand for money function; monetary policy in Egypt.

JEL: E310, E410, E510, E520, E580, E590.

1. Introduction

Beginning of the 1990s decade and after the first adoption of Inflation Targeting (IT) by New Zealand, an increasing number of developed countries and emerging market economies adopted IT as a framework for their monetary policy. The numbers of prospective candidates for IT are also increasing. A recent survey by IMF staff (Batini, Nicoletta, et al., 2006, P. 5, and P. 8) revealed that the number of non-industrial countries intending to change their monetary policy frameworks to the IT is increasing in the near, medium, and long-term.

IT has been introduced as a framework for monetary policy under the assumption that the main goal of monetary policy is to achieve a low and a stable rate of inflation. Such an assumption is widely accepted today. Paul R. Masson, et al. (1998, 34) and Truman, E. M. (2003, 5) indicated that the reason such an assumption became widely accepted may refer to the general agreement on the following assumptions: (i) money supply is neutral in the long-run. That is, in the long-run money supply dose not affect the real variables. Conversely, money supply is not neutral in the short-run. That is monetary policy has transitory effects on the real variables in the short-run; (ii) monetary policy lags are long and variable. Consequently, the Central Bank (CB) will find it difficult, if not impossible, to conduct monetary policy to control inflation upon a period-by-period basis; and (iii) high and variable inflation is costly in terms of the long-term growth rate of the real output.

Upon the aforementioned survey by IMF staff, Egypt is one of the prospective candidates to apply IT regime in the near-term (1-2 years). The main objective of this paper is to answer the question of whether the switching to the IT regime is necessary for the Egyptian case or not? Our judgment of applying IT regime in the Egyptian economy will be established on doubled criterion. That is, the practical experience of the inflation targeters, and the efficiency MTR in the Egyptian case.

I organized this paper as follows: Section 2 discusses definitions, preconditions, and motives to the IT regime. Section 3 Measures the efficiency of MTR in Egypt. Section 4 concludes.

2. IT regime: definitions, preconditions, and motives

2.1 Definitions of IT

Generally speaking, there is no standard definition of IT[1]. However, we may think of IT as a way to reform monetary policy through anchoring individuals' expectations about inflation around an announced target. In a flexible IT regime the short-term interest rate serves as the operational target of the monetary policy. The connection between the operational target and the ultimate target (s) is the inflation forecast level, which serves as the intermediate target of monetary policy. The inflation forecast, for this reason plays a pivotal role in the process of targeting.

IT as a constrained discretion is a way of implementing the optimal policy reaction function[2]. The CB or the government determines the targeted level/range of inflation. Upon the forecasted level of inflation the CB moves the short-term interest rate to drive the expected, and consequently the actual, rate of inflation towards the targeted level. The targeted level of inflation should be publicly announced to serve as an "anchor" for individuals expectations about the future behavior of inflation. The

[1] In literature there is no standard definition of IT, rather there are different definitions; see for example: Debelle, Guy, et al. (1998, 2), Svensson, Lars E.O. (1998, 13), Batini, Nicoletta, et al. (2005, 161), Bernanke, Ben S., and Woodford, Michael (2005, 1), and King, Mervyn (2005, 13).
[2] In fact, most economists look to the IT as a constrained discretion. The constraint is the inflation target and the discretion is the scope to take account of the short-run economic and financial considerations. For more details see; Truman, E. M. (2003) and Bernanke, Ben S., and Fredirec S. Mishkin (1997).

announced target of inflation is expected to play the role of anchoring the individuals' expectations as long as the CB's credibility is higher. That is why CB's credibility represents the corner stone in a successful IT regime. Accountability, transparency, and independency are three basic pillars for CB's credibility.

2.2 Preconditions of IT

To date, there are considerable debates among economists about "preconditions" that countries have to meet before applying IT. These debates reflect the fact that there is no generally agreed set of preconditions[3]. The disagreement among economists is mainly in regards to the question, 'what are the initial conditions or preconditions that have to be met before applying IT, particularly in an emerging market economy? In the vast majority of literature addressed this point; there are always three elements are generally demanded before applying IT, especially in the developing countries and emerging market economies. That is; (i) factual (*de facto*) independent of central bank[4]; which include three basic pillars: legal instrument independent of CB, nonexistence of the government representatives in the MPC as voting members; and absences of fiscal dominance including no obligation for CB to finance budget deficit, and domestic financial markets should have enough depth to absorb placements of public debt such as treasury bills; (ii) commitment to price stability which requires two basic elements: CB should not target any other variables rather than the rate of inflation, and CB should be transparent to the public about the exemptions of its inflation target. Such a transparency is a practical device to make CB accountable to the public for achieving the inflation target; and (iii) forecasting capabilities which include: a model for inflation forecasting and inflation projections, CB has to have clear idea about monetary policy transmission mechanisms and the associated lags, and an inclusive and updated database has to be available.

2.3 Motives to the IT regime

A rapidly widespread of IT regime in different countries led to the question of 'Why some countries decided to switch their monetary policy regimes to the IT

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[3] See for example; Khan, Mohsin S. (2003, 10), Truman (2003, 49), and Batini, Nicoletta, et al. (2006, 18)

[4] See; Truman (2003, 49-51), Paul R. Masson, et al. (1998, 35), Batini, Nicoletta, et al. (in IMF, 2006, 18), Debelle, Guy, et al. (1998, 11-13), Fraga, Arminio, et al. (2003, 22-25), and Mishkin, Fredric S., and Schmidt-Hebbel, Klaus (2007).

regime?' Two factors are standing behind such evolution; IT is a way to reform monetary policy, and IT does not worsen economic performance[5].

2.3.1 IT is a way to reform monetary policy; it is widely accepted today that a monetary policy regime is efficient as long as such a monetary policy regime is able to achieve the goal of price stability[6]. In this respect, a nominal anchor of monetary policy is necessary for price stability because it ties down individuals' expectations about the price level[7]. Thus, the efficiency of a monetary policy regime is determined, in the first of all, by the efficiency of the embedded nominal anchor to send the right message to all practitioners about the potential behavior of the price level. In this context, IT is a way to reform monetary policy by anchoring individuals' expectations of inflation around an announced target of inflation.

One lessons from the experience of some emerging market economies during the second half of the nineties decade is that countries like Czech Republic, Poland, and Brazil (hereafter CPB) were forced to float their currencies on the aftermath of the economic crises in order not to lose influential part of their foreign reserves. The decision of floatation came on the aftermath of speculative attacks on domestic currency triggered by both economic crises and external imbalances of current accounts. The imbalances of current accounts emerged as a result of pegging foreign exchange rate in conjunction with high domestic inflation thereby real appreciation occurred. After floating their currencies, the CPB found that IT regime is the only available alternative to achieve the goal of price stability upon forward-looking bases. On one hand, monetary policy regime without explicit nominal anchor was not the appropriate alternative to tie down individuals' expectations about the future path of inflation especially CBs in these countries did not have track record of credibility. On the other hand, a monetary targeting regime was not also an appropriate alternative especially after the liberalization of capital flows and financial markets which

[5]Of course there are different factors for the rapid widespread of IT, but these factors are related with the two mentioned factors in the text. Epstein, Gerald (2007), for instance, think that the widespread of IT refers to the IMF increasingly using the loan conditions and technical assistance to promote the use of IT in developing countries and emerging market economies.

[6] An operational definition of price stability that is now broadly accepted among economists is the definition presented by Alan Greenspan; price stability is obtained when economic agents no longer take account of the prospective change in the general price level in their economic decision making (Batini, Nicoletta, et al., 2005, 161).

[7] Mishkin, Frederic S. (1999, 1) defines a nominal anchor as a constraint on the value of money. It provides conditions that make price level uniquely determined. A nominal anchor for this reason is a device to bind individual's expectations about the nominal price level.

undermined the relationship between money supply and price level (Schaechter, Andrea, et al. 2000; Jonas, Jiri and Mishkin, Frederic S., 2003; Fraga, Arminio, 2000; Arestis, Philip, et al., 2008).

2.3.2 IT does not worsen economic performance; in literatures there is no agreement among economists about the contribution of IT in the economic performance, e.g. Truman (2003, 33) refers the widespread of IT especially during the nineties decade to the suitable global macroeconomic environment during this period which gave a good name and a good start to the inflation targeting regime.

However, disagreement among economists about the contribution of IT in the economic performance may be referred to the conflicted results of the empirical studies. On one hand, Mishkin and Schmidt-Hebbel (2000) found that IT is beneficial especially on reducing the rate of inflation, reducing the sacrifice ratio and output volatility, guiding inflation expectations and dealing better with inflation shocks, reinforcing central bank independency, and mutually reinforcing communications, transparency, and accountability. Neumann, Manfred J.M., and Jurgen Von Hagen (2002) found similar results regarding the volatility of inflation and output. Also, Landerretche, Oscar, et al. (2001) found similar results about the output sacrifice, the volatility of industrial output, and reducing inflation forecast errors based on country VAR's models.

On the other hand, some studies found that IT did not contribute in economic performance. Bernanke, et al. (1999), show that the adoption of IT did not make a difference with regard to the cost and speed of price stabilization. Cecchetti, S.G., and Ehrmann, Michael (1999) find that the degree of inflation aversion and consequently the degree of output volatility in the inflation targeting-countries in average is not higher than those of non-targeters. Comparing 7 inflation targeters to 13 non-targeters, Laurence, Ball, and Niamh, Sheridan (2003) found that Performance improved in both groups after the early of 90s and there is no evidence that IT improved performance.

However, Hu, Yifan (2003) takes medial stance through results of empirical study about 66 countries for the period 1980-2000. The author found limited support for the proposition that the adoption of IT improves the trade-off between inflation and output variability although IT does play a beneficial role in improving the performance of inflation and output.

Nevertheless, the clear point in the empirical studies is that IT does not worsen economic performance in the inflation targeters.

3. Measuring the efficiency of Monetary Targeting Regime (MTR) in Egypt

The economic circumstances occurred in Egypt during the nineties decade were very similar to those in the CPB. The application of the economic reform program with the advent of the nineties decade and the pegging of foreign exchange rate for long periods of time are two common aspects between Egypt and the CPB. The main deference, however, was the reaction of the Central Bank of Egypt (CBE) to economic crises encountered the economy in the second half of the nineties decade. While CBs in the CPB reacted to economic crises by switching their monetary policy regimes to the IT regime immediately after floating domestic currency the CBE did not[8]. Although, domestic currency (Egyptian Pound) subdued to successive devaluations during 2000-2002 and formally floated in 2003 the CBE did not switch to the IT regime. The CBE announced in several occasions about its intention to adopt IT regime as a framework for its monetary policy once the fundamental prerequisites are met (CBE, 2005; Batini, Nicoletta, et al., 2006; IMF, 2007). One of the fundamental questions has to be answered before the switch to the IT regime is the question of ‘is there existing relationship between money and prices in the Egyptian economy? The rest of this paper will be devoted to answer this question through considering whether MTR is efficient in the case of Egypt or not.

As mentioned, the efficiency of a monetary policy regime is determined by the efficiency of the embedded nominal anchor to send the right message to all practitioners about the potential behavior of the price level. Thus, we may assess the efficiency of the MTR in the Egyptian economy by measuring; whether there is a relationship between money and prices, the stability of the velocity of circulation, and the stability of the demand for money function.

[8] For more details about stance of the CBE of these crises See; Panizza, Ugo (2001) and Kamar, Bassem and Bakardzhieva, Damyana (2003).

3.1 The relationship between money and prices in the Egyptian economy

3.1.1 The variables and data; as the CBE targets the rate of growth of M2 I employed the variable M2 to measure the movements of the supply of money in the Egyptian economy. As a measurement of the rate of inflation, I used the change in the CPI. The adoption of the CPI rather than the other measurements of inflation refers to two considerations. The first concerns the data, where the quarterly data about the CPI is available for long periods. The second consideration is the wide use of the CPI. Although the CPI may involve some bias upward, it represents the most measurement commonly used for inflation in both empirical studies and monetary policy analysis. The source of quarterly data of both M2 and CPI is the IFS, CD-R 2008.

The analysis covers the period's 1991Q1-2007Q1. The choice of the year 1991 as a point of departure of the analysis refers to the fact that the periods as of 1991 are completely distinguished from the other previous periods. The Economic Reform and Structural Adjustment Program (ERSAP) endorsed by IMF and WB in 1991 represents a watershed between two different epochs of the economic regimes and consequently economic policy in the Egyptian economy[9].

3.1.2 The stationarity of the time series M2 and CPI; Plotting both time series CPI and M2 against time gives the perception that they are nonstationary (Appendix 1, Figure 1; part a, and b). Plotting the autocorrelation function (ACF) through the correlogram asserted our initial clue about the nonstationarity of both CPI and M2 (Appendix 1, Figure 1; part c, and d) where the first values are close to one.

One of the most popular tests of time series stationarity in the past several years is the unite root test. Beside the ACF, I used the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) unit root tests to determine the stationary time series of both CPI and M2. I performed the unit root test on the two time series CPI and M2. The two time series CPI and M2 are found to include a unit root, but The first differences of both logarithm CPI (Δ LnCPI) and logarithm M2 (Δ LnM2) are found stationary process (Appendix 1, Tables 1-4).

3.1.3 The long-run relationship between money and prices in the Egyptian economy; Does a relationship exist in the long-run between money and prices in the Egyptian economy? The answer to this question depends on the cointegration relationship between money and prices. According to Granger's representation

[9] For more details about the ERSAP See; Korayem, Karima (1997) & Awad, Ibrahim L. (2002).

theorem, if two variables, say Y and X, are individually integrated of order one but the residuals from the cointegrating regression are stationary then there is a long-run relationship between these two variables.

In the light of this, the first differences of both logs CPI and M2 are stationary. Therefore, the time series of both LnCPI and LnM2 is integrated of order one, i.e. LnM2~ I (1) and LnCPI ~ I (1). To determine whether there is a cointegration relationship between money and prices we may simply regress LnCPI on LnM2 and test the stationarity of the residuals. In other words we may apply the unit root tests on the residuals of the following regression;

$$LnCPI = \beta_0 + \beta_1 LnM2 + \varepsilon_{t1} \qquad (1)$$

Testing the residuals of equation 1, the ADF unit root test (Appendix 1, Table 5) does not reject the null hypothesis, i.e. the residuals are not stationary. According to the Breusch-Godfrey (LM) test for serial correlation (Appendix 1, Table 6), the residuals are serially correlated which means that the residuals from regression 1 are nonstationary. The first value of the ACF is found close to one, which indicates nonstationarity of the residuals with high probability. The behavior of the residuals of equation 1 (Appendix 1, Figure 4) exhibits a nonstationary behavior.

In the light of these results, we may conclude that the variables LnCPI and LnM2 are not cointegrated. Consequently, there is no long-run relationship between money and prices in the Egyptian economy.

3.1.4 The short-run relationship between money and prices in the Egyptian economy; the nonexistence of a long-run equilibrium relationship between money and prices in the Egyptian economy does not contradict with the fact that a short-run relationship may exist between the two variables. We may express the short-run relationship using the stationary variables Δ LnM2 and Δ LnCPI.

Regressing Δ LnCPI on Δ LnM2 (Appendix 1; Table 7), a positive serial autocorrelation is found where the value of Durbin-Watson statistic is very low. Using the following transformed form (Appendix 1; equation 1.3)[10];

$$\Delta LnCPIW = \beta_1 + \beta_2 \Delta LnM2W + \varepsilon_{t1} \qquad (2)$$

[10] The easiest way to explore the relationship between the two variables in such a case is to estimate the regression Δ LnCPI on Δ LnM2 with AR (1), or higher order, to eliminate the autocorrelation and then to assess whether there is a significant relationship between the variables. I applied this method with AR (1) where the serial autocorrelation is eliminated. However, the relationship between Δ LnCPI on Δ LnM2 was not significant

The estimation results (Appendix 1; Table 8) indicated that there is no short-run relationship between money and prices in the Egyptian economy.

3.1.5 The causality relationship between money and prices within an unrestricted VAR model; I considered different method to explore the relationship between money and prices in the Egyptian economy. Detecting causality relationship between the two variables is indicator that a relationship exists. I checked the causality relationship between money and prices in the Egyptian economy using an unrestricted VAR model with the following form:

$$LnCPI_t = \beta_0 + \sum_{i=1}^{k} \lambda i\,(LnCPI)_{t-i} + \sum_{i=1}^{m} \alpha i\,(LnM2)_{t-i} + \varepsilon_{1t}, \qquad (3)$$

$$LnM2_t = \eta_0 + \sum_{i=1}^{k} \gamma_i\,(LnCPI)_{t-i} + \sum_{i=1}^{m} \delta_i\,(LnM2)_{t-i} + \varepsilon_{2t} \qquad (4)$$

Where, ε_{1t} and $\varepsilon_{2t} \sim iid\,(0, \sigma^2)$

I estimated the above model for the period 1991:1-2007:1. According to the stability test, the model does not satisfy the stability condition. At least one root is found outside the unite circle (Appendix 1; Table 9).

One of the possible reasons of such instability in the VAR estimations is the change of the economic policy during this period. As mentioned, after long periods of pegging foreign exchange rate the Egyptian government floated it as of January 2003. Such a change of the economic policy might have impacted upon the parameters of the model.

I estimated the above VAR model for the period 2002:4 - 2007:1(Appendix 1; Table 10). The model satisfies the stability condition where all the roots lay inside the unit circle. Also, the model satisfies the normality test of the residuals according to the Jarque-Bera test. Testing for a causality relationship the Wald test of Granger causality indicated that there is no causality relationship between money and prices in the Egyptian economy (Appendix 1; Table 11).

3.2 The stability of the Velocity of circulation

The determinants of the velocity of circulation (*V*), and consequently its stability, are a subject of controversy among economists. In the light of the quantity theory of money, price level (*p*) is determined only by the nominal supply of money (*M*). The explicit assumption is that the real output (*Q*) is constant in the long-run whereas the implied assumption is that the individuals' expectations about the price level are stable. If individuals' expectations are adaptive then the previous change in the price level (not because of the change in the supply of money but because of some other exogenous factors) will lead to direct changes in the velocity of circulation.

Consider the simple quantity theory that yields the ex-post relationship given as;

$M.V \equiv P.Q \qquad (5),$

If *V* is found stationary then the variables in the quantity equation are stationary, or are not stationary but cointegrated. Whereas, the nonstationarity of the *V* is indicator not only that the variables in the quantity equation are nonstationary, but also that the long-run relationship between the nominal supply of money and the nominal GDP (*NGDP*) (=*P.Q*) has broken down [see Appendix 2]. The break down of the relationship between the nominal supply of money and the *NGDP* may happen if at least one of the three variables (*P*, *Q* and *M*) was moving separately from the other two variables (no cointegration relationship). In the last case we may find also that the relationship between both *M* and *P*, or the real GDP (*RGDP*) has broken down[11].

In the light of this I will check the stationarity of *V* and the cointegration relationship between *M2* (= *M*) and *NGDP* in the Egyptian economy. Since the quarterly data about the *NGDP* is not available in our source (IFS, CD-R 2008) I will use the time series available on the website of the CBE[12], which covers the periods from 2002. Therefore, the analysis in this section will cover only the period 2002Q4 – 2007Q1.

The ADF and PP unite root tests on the variables *V*, *RGDP* and *NGDP* revealed that these variables are nonstationary (Appendix 2; Tables 12-14). The second difference of Logarithm *NGDP* (Δ^2 *Ln NGDP*) is stationary while the first difference of *RGDP* (Δ *RGDP*) is stationary (Appendix 2; Tables 15-16). The ADF unite root test on the variables *M2* and *CPI* during the current period showed that the first difference of Log *M2* is stationary whilst the second difference of *CPI* (Δ^2 *CPI)* is stationary.

[11]For empirical analysis about the relationship between money and prices in the context of a mean-reverting velocity of circulation see; Hollman, Richard D., et al. (1991), and Crowder, William J. (1998).

[12] http://www.cbe.org.eg/timeSeries.htm

To test whether there is a cointegration relationship between *NGDP* and *M2* I followed the same procedures as in section 4.1. The residuals of the regression *Δ Ln NGDP / Ln M2* (where both of them are integrated of order 1) are nonstationary (Appendix 2; Table 17). According to the Johansen cointegration test (Appendix 2; Table 18) the variables *Ln M2* and *Δ Ln NGDP* are not cointegrated. Granger causality test (Appendix 2; Table 19) indicates that there is no (Granger) causality relationship between the two variables. In the light of these results, we may interpret the nonstationary of *V* in the Egyptian economy by the break down of the long-run relationship between *NGDP* and *M2*.

To answer the question why such a long-run relationship between *NGDP* and *M2* does not exist in the Egyptian economy? We may check the cointegration relationship between *M2* and either *P* or *RGDP*[13].

To test whether there is a cointegration relationship between *M2* and *RGDP* I estimated the regression *RGDP / Ln M2* (Appendix 2; Table 20) where the two variables are integrated of order 1. The residuals of this regression are stationary (Appendix 2; Table 21). According to the Johansen cointegration test, and the Granger causality test the variables *Ln M2* and *RGDP* are cointegrated, and *Ln M2* (Granger) cause *RGDP* (Appendix 2; Tables 22-23).

To test whether there is long-run relationship between *M2* and *P* during the current period I estimated the regression *Δ CPI / Ln M2* (where the two variables are integrated of order one). The residuals of this regression are found nonstationary. According to the Johansen cointegration test (Appendix 2; Table 24), the variables *Ln M2* and *Δ CPI* are not cointegrated. The Granger causality test indicated that there is no causality relationship between the two variables (Appendix 2; Table 25).

Summarizing, while the nonstationary of *V* in the Egyptian economy is interpreted by the break down of the long-run relationship between *NGDP* and *M2*, the break down of the relationship between *M2* and *NGDP* is interpreted by the break down of the relationship between *M2* and *P* in the long-run.

3.3 The Stability of the demand for money function

[13] The theoretical base of analyzing the cointegration relationship between *M2* and *P* depends on the monetarists' hypothesis which implicitly assumes that the economy approaches full employment. In the case of Egypt where the formal rate of open unemployment is higher than 11 % in the past five years it will be valid to analyze the cointegration relationship between M2 and real GDP.

One of the fundamental assumptions of the MTR is a stable relationship has to be existed between money supply and prices. Under this assumption, the CB can achieve the goal of price stability by moving money supply to affect the actual price levels. The other, and related, assumption of the MTR is the demand for money function has to be stable. Without a stable demand for money function the CB will not be able to predict the demand for money. Consequently the CB will not be able to determine how much change in the money supply is required to meet the demand for money. As a result, the CB will not be able to achieve the goal of price stability.

The instability of the demand for money may be illustrated by the instability of the velocity of circulation. More frequently, the instability of the demand for money is illustrated in terms of the demand for money function. Anderson, Palle S. (1985) identified three sources of the instability in the demand for money; (i) the change of the velocity of circulation in response to fluctuations in the interest rates as well as the movements in the other arguments of money demand function rather than real income, (ii) the money demand function itself may shift. For instance, financial innovations and deregulation of interest rates may shift the demand of money at the prevailing levels of the nominal interest rates, (iii) over shorter periods the money stocks actually held may not correspond to the money balances desired. If the speed of adjustments is low then such discrepancies will induce large and unexpected changes in the velocity of circulation.

In this section our objective is to consider the stability of the demand for money function in terms of its determinants. Besides to the RGDP, the nominal interest rate (R) affects the real demand for money because of its effect on the opportunity cost of holding money. Hetzel, Robert L. (1984) used a typical equation expressing the public's demand for real money balances (M^*) in the following form;

$$M^* = F(X) = e^k e^{-at} R^{-b} Y^c \qquad (6),$$

M^*, the desired real money balances, is a function of nominal interest rate (R) and real income (Y). Where, (k) is constant, and (at) is the trend rate of growth in income velocity of money.

Practically, measuring the stability of the demand for money function is performing by checking the stability of the following regression (Hetzel, 1984; Mehra, 1993);

$$Ln\,(M/P)_t = \beta_1 + \beta_2 LnY_t + \beta_3 Ln\,R_t + \varepsilon_t \qquad (7)$$

Wagner, Jun R.(1981) indicated that once the interest rate appears in the demand for money function, a stable demand for money function no longer implies a stable monetary multiplier. The main defect of the equation *7* is that it does not take into account the effect of the expected change in the price level on the real demand of money. Al-Sowaidi, Saif S. and Darrat, Ali F. (2006) included the expected inflation in the demand for money function. Where, both the expected inflation and nominal interest rate affect the opportunity cost of holding money. The lagged values of the rate of inflation are used as measurement for the expected inflation.

In the light of this, we may check the stability of the following form of the demand for money function in the Egyptian economy;

$$(M/P)_t = \beta_1 + \beta_2 (RGDP)_t + \beta_3 (R)_t + (\pi^e)_t + \varepsilon_t \qquad (8)$$

Where, π^e is the expected rate of inflation, equal to the lagged value of the inflation rate (= π_{t-1}).

The period of the study is constrained by the availability of data. As mentioned, the quarterly data available for the nominal GDP is only for the period's 2002Q4-2007Q1, therefore our analysis will cover only this period.

Which rate of interest might be used? As the Egyptian economy became more liberalized, especially after liberalizing exchange rate and the deregulation of the domestic interest rates, the structure of domestic interest rates is dominated by the directions of the international interest rates. Therefore, we may use either the LIBOR rate or, an average of the domestic interest rates as a measurement of the nominal interest rate included in equation *8*.

Figure 5 (appendix 3) shows that the TBs rate is mostly laying between both lending and depositing rates. Unfortunately the use of the TBs rates as a proxy for the nominal interest rates is cancelled. Figure 6 (appendix 3) shows the behavior of the demand for money variables where the TBs rate, in contrast with the other included variables, seams stationary. According to the ADF unite root test TBs rate is integrated of order zero (appendix 3, Table 26). As the time series of the TBs rates is found stationary, i.e. I~ (0), we couldn't include it in our analysis to estimate the long-run demand for money function. The individual time series of both CPI and LIBOR are integrated of order two while Ln (M2/P) is integrated of order one (appendix 3, Tables 27-29). As mentioned, RGDP is integrated of order one.

In the light of the above analysis we may measure the stability of the demand for money function in the Egyptian economy through two steps. The first step is to estimate the long-run demand for money function. The second step is to consider whether such a long-run relationship is stable or not.

The long-run demand for money function may be estimated in the Egyptian economy through the following form, where all the included variables are integrated of order one;

$$Ln\ (M/P)_t = \beta_1 + \beta_2\, RGDP + \beta_3\, \Delta\ LIBOR_t + (\Delta\ CPI)_{t-1} + \varepsilon_{t1} \qquad (9)$$

Since the individual variables of equation *9* are integrated of order one then the existence of a long-run relationship depends on whether the residuals of *9* are stationary or not. According to the ADF unit root test, PP unit root test and the Q-statistic test the residuals of equation *9* are stationary (see appendix 3, Figure 7 and Table 32). Consequently, equation *9* captures the long-run demand for money in the Egyptian economy.

The second step is to check whether the existing long-run demand for money function is stable or not. Different tests of stability may be used. Specifically, to check the stability of the long-run relationship depicted by *9*, I used Chew's Breakpoint test, Chew's forecast test, and the recursive residuals test (see appendix 3).

Using the point 2005:1 to check for structural change in *9*, Chow's tests (appendix 3, Tables 33-34) indicated for structural change. Where, the null hypothesis is rejected in the two tests according to the value of both F-statistic and the likelihood ratio-statistic. According to the Recursive Residuals test (appendix 3, Figure 8) the parameters of equation *9* are not stable through the time.

4. Conclusion

This paper intended to answer the question of whether the switching to the Inflation Targeting (IT) regime is necessary for the Egyptian case or not? Our judgment of applying IT regime in the Egyptian economy is established on doubled criterion. That is, the practical experience of the inflation targeters, and the efficiency of Monetary Targeting Regime (MTR) in the case of Egypt. Defining the efficiency of a monetary policy regime by the efficiency of the embedded nominal anchor to send the right message to all practitioners about the potential behavior of the price level, I assessed the efficiency of MTR in Egypt by measuring; whether there is a relationship between money and prices, the stability of the velocity of circulation, and the stability of the demand for money function.

The results of the study came as follows: (i) the relationship between money and prices in the Egyptian economy is loosened either in the short-run or in the long-run; (ii) the velocity of circulation (V) is found nonstationary, and there is no cointegration relationship between the supply of money (M2) and the nominal GDP (NGDP); and (iii) by estimating the demand for money function in the long-run and checking its stability the results indicated that the demand for money function is not stable in the Egyptian economy.

In the light of the above results the study concludes that MTR is not efficient in the Egyptian case to tie down individuals expectations of inflation. Taking into account that IT regime is a way to reform monetary policy and it does not worsen economic performance in the inflation targeters, it becomes necessary for Egypt to switch to the IT regime once its prerequisites have been met.

Appendices

Appendix 1: The relationship between Money and Prices in the Egyptian Economy

1.1. The variables and the data

The question is: does a relationship exist between money and prices in the Egyptian economy? The answer may guide us to assess the efficiency of the currently applied approach by the Central Bank of Egypt (CBE), which is known as Monetary Targeting regime (MTR). One of the fundamental factors of a successful MTR is the strong relationship between the intermediate target, i.e. money supply, and price level. Without such a strong relationship the CB would not be able to achieve the goal of price stability by controlling the supply of money. Since the CBE applies a MTR and uses the rate of growth of M2 as an intermediate target of its monetary policy, I will use M2 to measure the movements of the supply of money in the Egyptian economy.

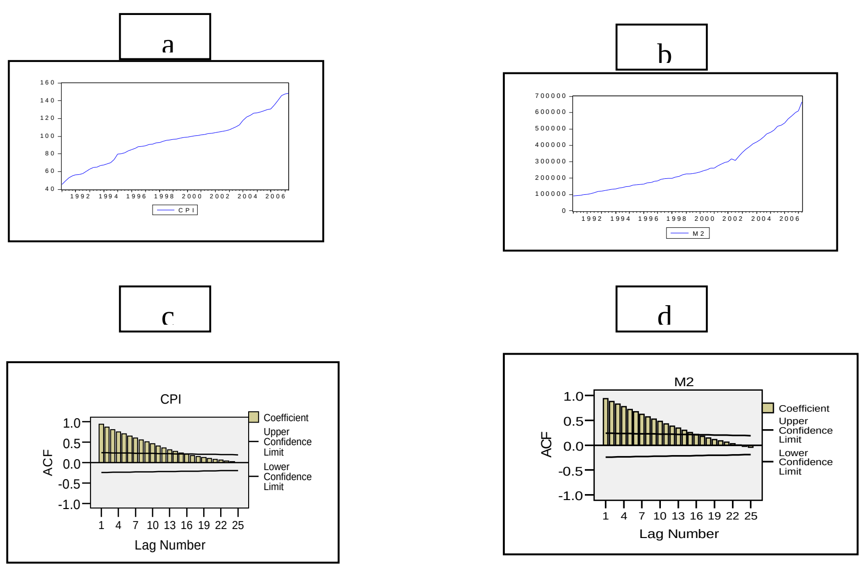
I will use the change in the CPI as a measurement of the inflation rate. The adoption of the CPI rather than other measurements is due to two considerations. The first concerns the data, where the quarterly data about the CPI is available for long periods. The second consideration is the wide use of the CPI. Although the CPI may involve some bias upward, it represents the most commonly used measurement for the inflation rate in both, empirical studies and monetary policy analysis. The source of the quarterly data for both M2 and CPI is the IFS, CD-R 2008. The analysis will cover the period's 1991Q1-2007Q1.

1.2 The stationarity of the time series M2 and CPI

The stochastic process is said to be stationary (weakly stationarity) if its mean and variance are constant over time, and the value of the covariance between the two random variables of the process depends only on the distance or the lag between the two time periods and not on the time. Conversely, a nonstationary process will have a time-varying mean or a time-varying variance, or both. Regressing two or more nonstationary time series may deliver misleading results, i.e. spurious regression.

Plotting both time series CPI and M2 against time gives the perception that they are nonstationary as shown in Figure 1, part a and b. Plotting the autocorrelation function (ACF) through the correlogram asserted our initial clue about the nonstationarity of both CPI and M2 as shown in Figure 1, part c and d where the first values are close to one.

Figure 1: The behavior of the time series M2 and CPI and the ACF



One of the most popular tests of time series stationarity in the past several years is the unite root test. Beside the ACF, I used the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) unit root tests to determine the stationarity time series of both CPI and M214. The ADF equation for a given time series (Y_t) takes this form:

$$\Delta Y_{t} = \beta_0 + \beta_1 t + \lambda Y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta Y_{t-i} + \varepsilon_{t}, \qquad (1.1)$$

Where, $\varepsilon_t \sim$ iid (o, σ^2), and $\lambda = (\rho - 1)$

The ADF test is regularly performed under three assumptions regarding the parameters of the equation; 1.1. In each case the null hypothesis is that the value of λ is equal to zero, i.e. ρ equals one, or the process under consideration involves the unite root and consequently it is not stationary.

I performed the unit root test on the two time series CPI and M2 under the three assumptions regarding the parameters of the equation 1.1. Mostly, the two time series CPI and M2 are found to include the unit root as shown in Tables 1-2.

The first differences of both log CPI and log M2 are found stationary process, as shown in Figures 2-3. Tables' 3-4 show the results of the ADF unit root test where both Δ (LnCPI) and Δ (LnM2) are "difference stationary process".

Table 1: The ADF unit root test on (CPI)

Case	ADF Equation			ADF Test		
	β_0	β_1	λ	ADF statistic (t)	ADF Critical values	
1	**0**	**0**	0.007	3.06	1% level 5% level 10% level	-2.601596 -1.945987 -1.613496
2	**0.432**	**0**	**0.0044**	**0..6937**	1% level 5% level 10% level	-3.5401 -2.9092 -2.5922
3	**6.033***	**0.16***	**- 0.124**	**- 2.381**	1% level 5% level 10% level	-4.1338 -3.44936 -3.17569

[14] The ADF test takes care of the serial correlation by adding the lagged difference terms of the dependent variable whilst, the PP test uses nonparametric statistical methods to take care of the serial correlation.

Table 2: The ADF unit root test on M2

Case	ADF Equation			ADF Test	
	β_0	β_1	λ	ADF statistic (t)	ADF Critical values
1	**0**	**0**	0.035	13.206	1% level -2.601024 5% level -1.945903 10% level -1.613543
2	**-2433.669**	**0**	**0.0421**	**7.692**	1% level -3.534868 5% level -2.906923 10% level -2.591006
3	**-2391.144**	**-88.3**	**0.0528**	**2.961**	1% level -4.105534 5% level -3.480463 10% level -3.168039

Figure 2: The behavior of Δ (LnCPI) as a stationary process

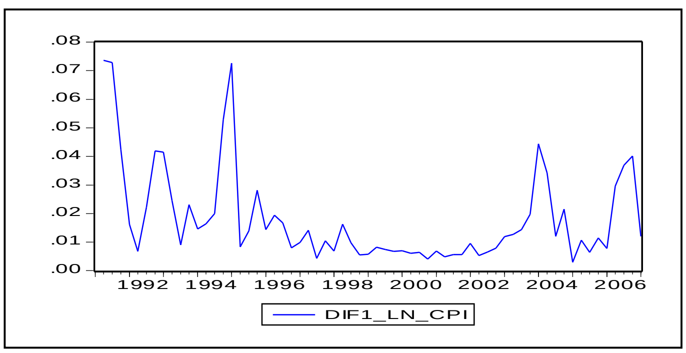


Figure 3: The behavior of Δ (LnM2) as a stationary process

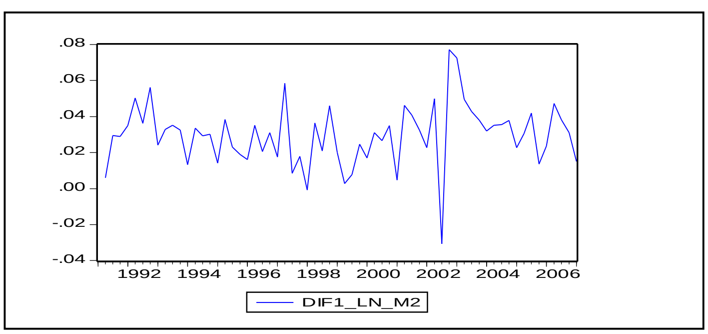


Table 3: The ADF unit root test on Δ (LnCPI)

Case	ADF Equation			ADF Test		
	β_0	β_1	λ	ADF statistic (t)	ADF Critical values	
1	**0**	**0**	**-0.229**	-3.463	1% level	-2.602185
					5% level	-1.946072
					10% level	-1.613448
2	**0.007**	**0**	**-0.436**	**-4.761**	1% level	-3.538362
					5% level	-2.908420
					10% level	-2.591799
3	**0.009**	**-6.75E-05**	**-0.46**	**-4.72**	1% level	-4.110440
					5% level	-3.482763
					10% level	-3.169372

Table 4: The ADF unit root test on Δ (LnM2)

Case	ADF Equation			ADF Test		
	β_0	β_1	λ	ADF statistic (t)	ADF Critical values	
1	**0**	**0**	**-0.05**	-0.667	1% level	-2.605442
					5% level	-1.946549
					10% level	-1.613181
2	**0.03**	**0**	**-1.06**	**-8.43**	1% level	-3.538362
					5% level	-2.908420
					10% level	-2.591799
3	**0.03**	**6.38E-05**	**-1.07**	**-8.39**	1% level	-4.110440
					5% level	-3.482763
					10% level	-3.169372

1.3 The long-run relationship between money and prices in the Egyptian economy

Does a relationship exist in the long run between money and prices in the Egyptian economy? The answer to this question depends on the cointegration relationship between money and prices. According to Granger's representation theorem, if two variables, say Y and X, are individually integrated of order one but the residuals from the cointegrating regression are stationary then there is a long-run relationship between these two variables.

In the light of the above analysis of stationarity, the first differences of both logs CPI and M2 are stationary. Therefore, the time series of both LnCPI and LnM2 is integrated of order one, i.e. LnM2~ I (1) and LnCPI ~ I (1). To determine whether there is a cointegration relationship (long-run equilibrium relationship) between money and prices we may simply regress LnCPI on LnM2 and test the stationarity of the residuals. In other words we may apply the ADF unit root test on the residuals of the following regression;

$$LnCPI = \beta_0 + \beta_1 LnM2 + \varepsilon_{t1} \qquad (1.2)$$

Table 5 shows the ADF unit root test on the residuals of the equation 1.2. As this result suggests, the residuals are not stationary. Figure 4 depicts the behavior of the residuals of the equation 1.2 as nonstationary process. The Breusch-Godfrey test for serial correlation (LM test) indicates that the residuals are serially correlated, as shown in table 6. The existence of the serial autocorrelation means that the residuals of regression 1.2 are nonstationary. The first value of the ACF is found close to one, which indicates nonstationarity of the residuals with high probability.

In the light of these results, one may conclude that the variables LnCPI and LnM2 are not cointegrated. Consequently, there is no long-run relationship between money and prices in the Egyptian economy.

Table 5: The ADF unit root test on the residuals of equation 2

Case Number	ADF Equation			ADF Test	
	β_0	β_1	λ	ADF statistic (t)	ADF Critical values
1	**0**	**0**	**-0.06**	-1.82	1% level -2.605442 5% level -1.946549 10% level -1.613181
2	**0.001**	**0**	**-0.06**	**-1.897**	1% level -3.548208 5% level -2.912631 10% level -2.594027

3	**0.008**	**-0.0001**	**-0.078**	**-2.206**	1% level -4.124265 5% level -3.489228 10% level -3.173114

Figure 4: The residuals of equation 2

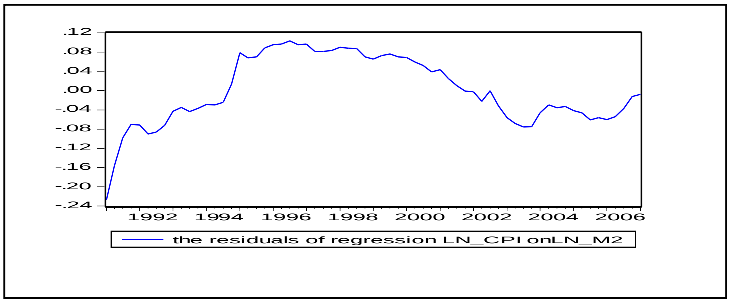


Table 6: Breusch-Godfrey Serial Correlation LM Test

F-statistic	109.2162	Prob. F (2,61)		0.000000
Obs*R-squared	50.81052	Prob. Chi-Square (2)		0.000000
Dependent Variable: RESID				
Method: Least Squares				
Sample: 1991Q1 2007Q1				
Included observations: 65				
Presample missing value lagged residuals set to zero.				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.002904	0.096978	-0.029950	0.9762
LN_M2	0.000226	0.007846	0.028848	0.9771
RESID (-1)	0.862483	0.128008	6.737725	0.0000
RESID (-2)	0.024512	0.128039	0.191440	0.8488

1.4 The short-run relationship between money and prices in the Egyptian economy

The above analysis leads to a conclusion that there is no long-run equilibrium relationship between money and prices in the Egyptian economy. This result does not contradict with the fact that a short-run relationship may exist between money and prices in the Egyptian economy. We may express the short-run relationship using the stationary variables Δ LnM2 and Δ LnCPI.

Regressing Δ LnCPI on Δ LnM2, as shown in table 7, the results indicate to the existence of a positive serial autocorrelation where the value of Durbin-Watson statistic is very low. The LM test indicated that the residuals are positively correlated of order one. Using the value 0.65 (= 1- (D-W) / 2) as estimation for the serial autocorrelation, I transformed the variables Δ LnM2 and Δ LnCPI to the following form[15];

$$\Delta \text{ LnCPIW} = \beta_1 + \beta_2 \Delta \text{ LnM2W} + \varepsilon_{t1} \qquad (1.3)$$

Where, Δ LnCPIW = Δ LnCPI – 0.65 (lag Δ LnCPI), and Δ LnM2W = Δ LnM2 – 0.65 (lag Δ LnM2).

Table 8 shows the estimation results of equation 1.3. As these results suggest, there is no short-run relationship between money and prices in the Egyptian economy.

Table 7: The estimation results of regressing Δ LnCPI on Δ LnM2

Dependent Variable: DIF1_LN_CPI				
Method: Least Squares				
Sample (adjusted): 1991Q2 2007Q1				
Included observations: 64 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.018894	0.004299	4.395108	0.0000
DIF1_LN_M2	-0.021285	0.126348	-0.168467	0.8668
R-squared	0.000458	F-statistic		0.028381
Adjusted R-squared	-0.015664	Prob (F-statistic)		0.866764
Durbin-Watson stat	0.705947			

Table 8: The estimation results of the transformed model (equation 1.3)

Dependent Variable: DIF1_LN_CPIW	

[15] The easiest way to explore the relationship between the two variables in such a case is to estimate the regression Δ LnCPI on Δ LnM2 with AR (1), or higher order, to eliminate the autocorrelation and then to assess whether there is a significant relationship between the variables. I applied this method with AR (1) where the serial autocorrelation is eliminated. However, the relationship between Δ LnCPI on Δ LnM2 was not significant

Method: Least Squares				
Sample (adjusted): 1991Q3 2007Q1				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.005423	0.001759	3.082540	0.0031
DIF1_LN_M2W	0.002621	0.075677	0.034635	0.9725
R-squared	0.000020	F-statistic		0.001200
Adjusted R-squared	-0.016373	Prob (F-statistic)		0.972484
Durbin-Watson stat	1.981223			

1.5 The causality relationship between money and prices within unrestricted VAR model

In this section I will use different method to explore the relationship between money and prices in the Egyptian economy. Detecting causality relationship between money and prices is indicator that there is an existing relationship. I will check the causality relationship within an unrestricted VAR model. In our case an unrestricted VAR model takes the following form:

$$LnCPI_t = \beta_0 + \sum_{i=1}^{k} \lambda i\,(LnCPI)_{t-i} + \sum_{i=1}^{m} \alpha i\,(LnM2)_{t-i} + \varepsilon_{1t}, \qquad (1.4)$$

$$LnM2_t = \eta_0 + \sum_{i=1}^{k} \gamma_i\,(LnCPI)_{t-I} + \sum_{i=1}^{m} \delta_i\,(LnM2)_{t-i} + \varepsilon_{2t} \qquad (1.5)$$

Where, ε_{1t} and $\varepsilon_{2t} \sim iid\,(0, \sigma^2)$

I estimated the above model for the period 1991:1-2007:1. According to the stability test, the model does not satisfy the stability condition. As shown in table 9, at least one root is found outside the unite circle. One of the possible reasons of such instability in the VAR estimations is the change of the economic policy during this period. As of January 2003, the Egyptian government floated the exchange rate and switched formally to the monetary targeting regime.

I estimated the above VAR model for the period 2002:4 - 2007:1, as shown in table 10. The model satisfies the stability condition where all the roots were lying inside the unit circle. According to the Jarque-Bera test, the model satisfies the normality test of the residuals. According to the Wald test for Granger causality there is no causality relationship between money and prices in the Egyptian economy as shown in table 11.

Table 9: The stability test of VAR for the period 1991-2007

Roots of Characteristic Polynomial	
Endogenous variables: LN_CPI LN_M2	
Exogenous variables: C	
Lag specification: 1 2	
Root	Modulus
1.004969	1.004969
0.876959	0.876959
0.494281	0.494281
-0.179985	0.179985

Table 10: The estimation results of the VAR model for the period 2002Q4 - 2007Q1

Vector Autoregression Estimates		
Sample: 2002Q4 2007Q1		
Included observations: 18		
Standard errors in ( ) & t-statistics in [ ]		
	LN_CPI	LN_M2
LN_CPI (-1)	1.220434	-0.008615
	(0.23200)	(0.24636)
	[5.26052]	[-0.03497]
LN_CPI (-2)	-0.580436	0.235024
	(0.23254)	(0.24693)
	[-2.49610]	[0.95179]
LN_M2 (-1)	0.087958	0.850768
	(0.11935)	(0.12674)
	[0.73695]	[6.71273]
LN_M2 (-2)	0.090845	-0.021314
	(0.13273)	(0.14094)
	[0.68444]	[-0.15122]
C	-0.587240	1.174203
	(0.29445)	(0.31267)
	[-1.99437]	[3.75539]

R-squared	0.991194	0.996931
Adj. R-squared	0.988484	0.995986
F-statistic	365.8022	1055.673

Table 11: Wald Test-Granger Causality for the period 2002Q4 - 2007Q1

VAR Granger Causality/Block Exogeneity Wald Tests			
Sample: 2002Q4 2007Q1			
Included observations: 18			
Dependent variable: LN_CPI			
Excluded	Chi-sq	df	Prob.
LN_M2	5.830844	2	0.0542
Dependent variable: LN_M2			
Excluded	Chi-sq	df	Prob.
LN_CPI	2.207975	2	0.3315

Appendix 2: The stability of the Velocity of circulation

The determinants of the velocity of circulation (V), and consequently its stability, are a subject of controversy among economists. In the light of the quantity theory of money, price level is determined only by the supply of money. The implied assumption is that the individuals' expectations about the price level are stable. If individuals' expectations are adaptive then the previous change in the price level (not because of the change in the supply of money but because of some other exogenous factors) will lead to direct changes in the velocity of circulation.

Consider the simple quantity theory that yields the ex post relationship given as;

$M.V \equiv P.Q$ (2.1),

The evolution of the above variables during the time may be written as follow:

$M (1+ r_m).V (1 + r_v) = P(1+ r_p).Q(1+r_q)$ (2.2),

Where, r_m, r_v, r_p, and r_q are the rates of growth of money, velocity, prices, and real GDP successively. Dividing 2 by 1 yields,

$r_v = [(1+ r_p) (1+r_q) / (1+ r_m)] - 1$ (2.3)

As equation 2.3 suggests, the stability of V depends on the behavior of the rates of growth r_p, r_q and r_m. The expected value of the individually rates of growth r_p, r_q, and r_m are equivalent to the value of λ in the DF unite root test. Therefore, the stationarity of V will depend on the value of λ for the variables P, Q and M. If the expected value of the individual rates of growth r_p, r_q and r_m (=λ) are negative, then the autoregressive coefficients of each variable are less than one, consequently the variables P, Q and M are stationary. Therefore, V is stationary. Conversely, if the expected value of the individually rates of growth r_p, r_q and r_m are positive or zero, then the autoregressive coefficients of each variable are higher than or equal to one, consequently the variables P, Q and M are not stationary. In this case, the stationarity of V depends on whether the variables P, Q and M are cointegrating or not. If cointegration relationship existed among these variables (although they are nonstationary), then V would be stationary. If not, then V will be not stationary.

In the context of this analysis we may conclude; if V is found stationary then the variables in the quantity equation are stationary, or are not stationary but cointegrated. Whereas, the nonstationarity of V is indicator not only that the variables in the quantity equation are nonstationary, but also that the long-run relationship between the nominal supply of money and the nominal GDP (NGDP) has broken down. The break down of the relationship between the nominal supply of money and the nominal GDP may happen if at least one of the three variables (P, Q and M) was moving separately from the other two variables. In the last case we may find that the relationship between both the nominal supply of money and the general price level (or the real GDP) has broken down[16].

The analysis in section 1 leads us to conclude that the relationship between money and prices in the Egyptian economy is loosened in both the short-run and the long-run. In this section I will utilize from the above analysis about the stationarity of V by checking the stability of V and the cointegration relationship between M2 and NGDP.

Since the quarterly data about the NGDP is not available in our source (IFS, CD-R 2008) I will use the time series available on the website of the Central Bank of Egypt[17] which covers the periods from 2002. Therefore, the analysis in this part will cover only the period 2002Q4 – 2007Q1.

The ADF and PP unite root tests on the variables V, real GDP (RGDP) and NGDP revealed that V is not stationary as shown in Table 12. Both NGDP and RGDP are non-stationary as shown in Tables 13-14. The second difference of Log NGDP is stationary while the first difference of RGDP is stationary, as shown in Tables 15-16.

[16] For empirical analysis about the relationship between money and prices in the context of a mean-reverting velocity of circulation see: Hollman, Richard D., et al. (1991), and Crowder, William J. (1998).

[17] http://www.cbe.org.eg/timeSeries.htm

The ADF unite root test on the variables M2 and CPI during the current period showed that the first difference of Log M2 is stationary (at level 5%) whilst the second difference of CPI is stationary (see appendix 3, Table 27).

To test whether there is a cointegration relationship between NGDP and M2 I followed the same procedures as in Appendix 1. The residuals of the regression Δ Ln NGDP / Ln M2 (where both of them are integrated of order 1) are nonstationary as shown in Table 17. According to Johansen cointegration test, as shown in table 18, the variables Ln M2 and Δ Ln NGDP are not cointegrated, i.e. there is no long-run equilibrium relationship between the two variables. Granger causality test, as shown in table 19, indicates that there is no (Granger) causality relationship between the two variables.

To test whether there is a cointegration relationship between M2 and RGDP I estimated the regression RGDP / Ln M2 (where the two variables are integrated of order 1), as shown in Table 20. The residuals of this regression are stationary as shown in Table 21. According to the Johansen cointegration test, as shown in table 22, the variables Ln M2 and RGDP are cointegrated. According to the Granger causality test Ln M2 (Granger) cause RGDP as shown in Table 23.

To test whether there is long-run relationship between money and prices during the current period I estimated the regression Δ CPI / Ln M2 (where the two variables are integrated of order one). The residuals of this regression are found nonstationary. According to the Johansen cointegration test, as shown in Table 24, the variables Ln M2 and Δ CPI are not cointegrated. The Granger causality test indicated that there is no causality relationship between Δ CPI and Ln M2, as shown in Table 25.

Generally, these results support our theoretical analysis about the stationarity of V. Since V is found nonstationary we did not find a cointegration relationship between M2 and NGDP. The break down of the relationship between M2 and NGDP means that one (at least) of the three variables P, RGDP, M2 is moving separately from the other two variables. In our case this variable is the price level.

Table 12: The ADF unite root test on the velocity of circulation (V)

Case	ADF Equation			ADF Test	
	β_0	β_1	λ	ADF statistic (t)	ADF Critical values

1	**0**	**0**	**0.006**	0.634	1% level 5% level 10% level	-2.771926 -1.974028 -1.602922
2	**-0.247**	**0**	**0.91**	**0.486**	1% level 5% level 10% level	-4.121990 -3.144920 -2.713751
3	**0.399**	**0.0008**	**-1.497**	**-1.5**	1% level 5% level 10% level	-4.886426 -3.828975 -3.362984

Table 13: The ADF unite root test of on the stationarity of the NGDP

Case	ADF Equation			ADF Test		
	β_0	β_1	λ	ADF statistic (t)	ADF Critical values	
1	**0**	**0**	**0.032**	0.688	1% level 5% level 10% level	-2.754993 -1.970978 -1.603693
2	**-12570.82**	**0**	**0.135**	**1.247**	1% level 5% level 10% level	-4.057910 -3.119910 -2.701103
3	**19470.38**	**1598.3**	**-0.26**	**-0.24**	1% level 5% level 10% level	-4.886426 -3.828975 -3.362984

Table 14: The ADF unite root test on the stationarity of RGDP

Case	ADF Equation			ADF Test		
	β_0	β_1	λ	ADF statistic (t)	ADF Critical values	
1	**0**	**0**	**0.036**	1.56	1% level 5% level 10% level	-2.771926 -1.974028 -1.602922

2	**-30716.4**	**0**	**0.34**	**1.624**	1% level -4.121990 5% level -3.144920 10% level -2.713751
3	**80790.8**	**1772.5**	**-0.95**	**-1.47**	1% level -4.886426 5% level -3.828975 10% level -3.362984

Table 15: The ADF unite root test on the stationarity of Δ^2 Ln NGDP

Case	ADF Equation			ADF Test	
	β_0	β_1	λ	ADF statistic (t)	ADF Critical values
1	**0**	**0**	**-3.7**	-9.67	1% level -2.754993 5% level -1.970978 10% level -1.603693
2	**0.005**	**0**	**-3.7**	**-9.3**	1% level -4.057910 5% level -3.119910 10% level -2.701103
3	**-0.022**	**0.002**	**-3.76**	**-9.21**	1% level -4.886426 5% level -3.828975 10% level -3.362984

Table 16: The PP unite root test on Δ RGDP

Case	PP Equation			PP Test	
	β_0	β_1	λ	PP statistic (t)	PP Critical values
1	**0**	**0**	**-1.51**	-6.52	1% level -2.717511 5% level -1.964418 10% level -1.605603

2	**2923.6**	**0**	**-1.6**	**-17.14**	1% level -3.920350 5% level -3.065585 10% level -2.673459
3	**2489.3**	**45.6**	**-1.6**	**-16.44**	1% level -4.667883 5% level -3.733200 10% level -3.310349

Table 17: The ADF unite root test on the residuals from regression Δ Ln NGDP/LnM2

Case	ADF Equation			ADF Test	
	β_0	β_1	λ	ADF statistic (t)	ADF Critical values
1	**0**	**0**	**-1.16**	-1.28	1% level -2.754993 5% level -1.970978 10% level -1.603693
2	**-0.027**	**0**	**-5.52**	**-2.51**	1% level -4.297073 5% level -3.212696 10% level -2.747676
3	**-0.09**	**0.005**	**-4.96**	**-2.21**	1% level -5.295384 5% level -4.008157 10% level -3.460791

Table 18: Johansen cointegration test on the variables Δ Ln NGDP and LnM2

Sample (adjusted): 2003Q4 2007Q1	
Included observations: 14 after adjustments	
Trend assumption: Linear deterministic trend (restricted)	
Series: DIF_LN_GDP_N LN_M2	
Lags interval (in first differences): 1 to 2	
Unrestricted Cointegration Rank Test (Trace)	

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.619005	25.34361	25.87211	0.0581
At most 1	0.570567	11.83404	12.51798	0.0649
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.619005	13.50957	19.38704	0.2887
At most 1	0.570567	11.83404	12.51798	0.0649

Table 19: Granger Causality test on Ln M2 and Δ Ln NGDP

Sample: 2002Q4 2007Q1			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Probability
LN_M2 does not Granger Cause DIF_LN_GDP_N	15	1.88489	0.20201
DIF_LN_GDP_N does not Granger Cause LN_M2		2.80699	0.10775

Table 20: The regression RGDP/LnM2

Dependent Variable: REAL_GDP				
Method: Least Squares				
Sample: 2002Q4 2007Q1				
Included observations: 18				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-585069.2	78932.46	-7.412277	0.0000
LN_M2	52727.78	6043.178	8.725174	0.0000
R-squared	0.826330	F-statistic		76.12866
Adjusted R-squared	0.815475	Prob(F-statistic)		0.000000
Durbin-Watson stat	2.404444			

Table 21: The ADF unite root test on the residuals from regression RGDP/LnM2

Case	ADF Equation			ADF Test	
	β_0	β_1	λ	ADF statistic (t)	ADF Critical values
1	**0**	**0**	**-1.28**	-5.22	1% level -2.708094 5% level -1.962813 10% level -1.606129
2	**-280.8**	**0**	**-1.28**	**-5.08**	1% level -3.886751 5% level -3.052169 10% level -2.666593
3	**-771.11**	**54.72**	**-1.27**	**-4.85**	1% level -4.616209 5% level -3.710482 10% level -3.297799

Table 22: Johansen cointegration test on the variables RGDP and LnM2

Sample (adjusted): 2003Q2 2007Q1				
Included observations: 16 after adjustments				
Trend assumption: Quadratic deterministic trend				
Series: REAL_GDP LN_M2				
Lags interval (in first differences): 1 to 1				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.662041	24.98048	18.39771	0.0052
At most 1 *	0.379016	7.623193	3.841466	0.0058
Trace test indicates 2 cointegrating eqn(s) at the 0.05 level				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.662041	17.35729	17.14769	0.0466
At most 1 *	0.379016	7.623193	3.841466	0.0058
Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

Table 23: Granger Causality test on RGDP and Ln M2

Pairwise Granger Causality Tests			
Sample: 2002Q4 2007Q1			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Probability
LN_M2 does not Granger Cause REAL_GDP	16	4.04210	0.04830
REAL_GDP does not Granger Cause LN_M2		1.01041	0.39550

Table 24: Johansen cointegration test on the variables Ln M2 and Δ CPI

Sample (adjusted): 2003Q3 2007Q1				
Included observations: 15 after adjustments				
Trend assumption: Linear deterministic trend				
Series: DIF_CPI LN_M2				
Lags interval (in first differences): 1 to 1				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.307581	5.807320	15.49471	0.7182
At most 1	0.019400	0.293859	3.841466	0.5878
Trace test indicates no cointegration at the 0.05 level				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.307581	5.513461	14.26460	0.6761
At most 1	0.019400	0.293859	3.841466	0.5878
Max-eigenvalue test indicates no cointegration at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

Table 25: Granger Causality test on Ln M2 and Δ CPI

Pairwise Granger Causality Tests			
Sample: 2002Q4 2007Q1			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Probability
LN_M2 does not Granger Cause DIF_CPI	15	0.01066	0.98941
DIF_CPI does not Granger Cause LN_M2		0.05052	0.95097

Appendix 3: The Stability of the demand for money function

The quantity theory exemplified by the Cambridge equation as shown in equation 2.1 explicitlyy omitted the interest rate from the demand for money function. In this section I will move step a head by including the other macroeconomic variables in the demand for money function.

Our objective is to consider the stability of the demand for money function in terms of its determinants. Besides to the RGDP, the nominal interest rate (R) affects the real demand for money because of its effect on the opportunity cost of holding money. Hetzel, Robert L. (1984) used a typical equation expressing the public's demand for real money balances (M^*) in the following form;

$M^* = F(X) = e^k e^{-at} R^{-b} Y^c$ 3.1

M*, the desired real money balances, is a function of nominal interest rate(R) and real income(Y). Where, k is constant, and at is the trend rate of growth in income velocity of money. Practically, measuring the stability of the demand for money function is performing by checking the stability of the following regression (Hetzel, Robert L. 1984, and Mehra, Yash P. 1993),

$\text{Ln}\,(M/P)_t = \beta_1 + \beta_2\,\text{Ln}Y_t + \beta_3\,\text{Ln}\,R_t + \varepsilon_t$ 3.2

Wagner, Jun R.(1981) indicated that once the interest rate appears in the demand for money function, a stable demand for money function no longer implies a stable monetary multiplier. The main defect of the equation 3.2 is that it does not take into account the effect of the expected change in the price level on the real demand of money. Al-Sowaidi, Saif S. and Darrat, Ali F. (2006) included the expected inflation in the demand for money function. Where, both the expected inflation and nominal interest rate affect the opportunity cost of holding money. The lagged values of the rate of inflation are used as measurement for the expected inflation.

In this context we might check the stability of the following form of the demand for money function in the Egyptian economy;

$$(M/P)_t = \beta_1 + \beta_2 (RGDP)_t + \beta_3 (R)_t + (\pi^e)_t + \varepsilon_t \qquad 3.3$$

Where, π^e is the expected inflation rate (= π_{t-1}).

The period of the study is constrained by the availability of data. As mentioned, the quarterly data available for the NGDP is only for the period's 2002Q4- 2007Q1, therefore our analysis will cover only this period.

Which rate of interest might be used in the equation 3.3? As the Egyptian economy became more liberalized, especially after liberalizing exchange rate and the deregulation of the domestic interest rates, the direction of the structure of domestic interest rates is dominated by the directions of the international interest rates. Therefore, we may use either the LIBOR rate or an average for the domestic interest rates as a proxy for the nominal interest rates in equation 3.3. Figure 5 shows the domestic interest rates where the TBs rate is mostly laying between both lending and depositing rates.

However, the use of the TBs rates as a proxy for the nominal interest rates is cancelled as the time series of the TBs rates is found stationary. Figure 6 shows the behavior of the demand for money variables. The behavior of the TBs rate, in contrast with the behavior of the other included variables, seams stationary. According to the ADF unite root test TBs rate is integrated of order zero (stationary) (Table 26), the individual time series of both CPI and LIBOR are integrated of order two (Tables 27-28), and Ln (M2/P) is integrated of order one (Table 29). According to the PP unite root test RGDP is integrated of order one (Table 30).

In the light of the above analysis we may measure the stability of the demand for money function in the Egyptian economy through two steps. The first step is to estimate the long-run demand for money function. The second step is to consider whither such a long-run relationship is stable or not.

The long-run demand for money function may be estimated in the Egyptian economy takes the following form, where all the included variables are integrated of order one;

$$Ln\ (M/P)_t = \beta_1 + \beta_2\ RGDP + \beta_3\ \Delta\ LIBOR_t + (\Delta\ CPI)_{t-1} + \varepsilon_{t1} \qquad 3.4$$

Table 31 shows the estimation results of equation 3.4. According to the value of the adjusted R^2 the explanatory variables included in the above equation explain 81 %

of the rate of change of the demand for money in the Egyptian economy. According to the Durbin-Watson statistic and the LM test there is no serial correlation. The ARCH-LM test did not detect ARCH effect.

Since the individual variables of equation 3.4 are integrated of order one then the existence of the long-term relationship depends on whether the residuals are stationary or not. According to the ADF unit root test, PP unit root test and the Q-statistic test the residuals of equation 3.4 are stationary. Figure 7 shows the stationary behavior of the residuals of equation 3.4. According to the Jarque-Bera normality test, the residuals are normally distributed. Besides, the Johansen cointegration test, as shown in Table 32, indicated obviously that a cointegration relationship existing. In the light of these results, we may conclude that equation 3.4 captures the long-run demand for money in the Egyptian economy.

The second step is to check whether the existing long-run relationship is stable or not. Different tests of stability may be used. Specifically, I will check the stability of the long-run relationship depicted by equation 3.4 using Chew's Breakpoint test, Chew's forecast test, and the recursive residuals test.

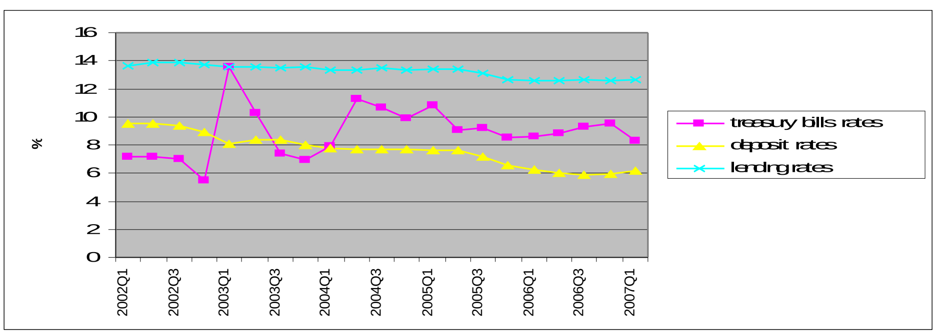
According to the Chow's breakpoint test the entire sample is divided into two or more sub-samples. The equation 3.4 is estimated separately for each sub-sample, and we test whether there are significant differences among the residuals of the estimated equations. A significant difference indicates a structural change in the relationship. Two test statistics for the Chow's breakpoint test are used. The F-statistic, based on the comparison of the restricted and unrestricted sum of squared residuals, and the log likelihood ratio statistic, based on the comparison of the restricted and unrestricted maximum of the log likelihood function. The test is performing under the null hypothesis of no structural change among the sub-samples.

According to the Chow's Forecast Test two models are estimated, i.e. one using the full set of data and the other using a long the sub-periods. A significant difference between the residuals of the two models is indicator for structural change. Two test statistics for the Chow's forecast test are used. The F-statistic, based on the comparison of the restricted and unrestricted sum of squared residuals, and the log likelihood ratio statistic, based on the comparison of the restricted and unrestricted maximum of the log likelihood function. Both the restricted and unrestricted log likelihood is obtained by estimating the regression using the whole sample. While the restricted regression uses the original set of regressors, the unrestricted regression adds a dummy variable for each forecast point. The test is performing under the null hypothesis of no structural change between the two models.

According to the Recursive Residuals test the equation is estimated repeatedly. If the model is valid, the recursive residuals will be independently and normally distributed with zero mean and constant variance. I used the Cumulative Sum of the recursive residuals (CUSUM) test. Where, the parameters of the model will be unstable if the cumulative sum of the recursive residuals goes outside the area with the 5% critical value.

Using the above mentioned criteria, I checked the stability of the equation 3.4. The point 2005:1 is to check whether there is structural change. Chow's tests, as shown in Tables 33-34, indicated for structural change. Where, the null hypothesis is rejected in the two tests according the value of both F-statistic and the likelihood ratio-statistic. According to the Recursive Residuals test, shown in Figure 8, the parameters of equation 3.4 are not stable through the time.

Figure 5: Interest rates in the Egyptian economy during the period 2002-2007



Source: IFS, CD-ROM, 2008

Figure 6: The behavior of the demand for money variables

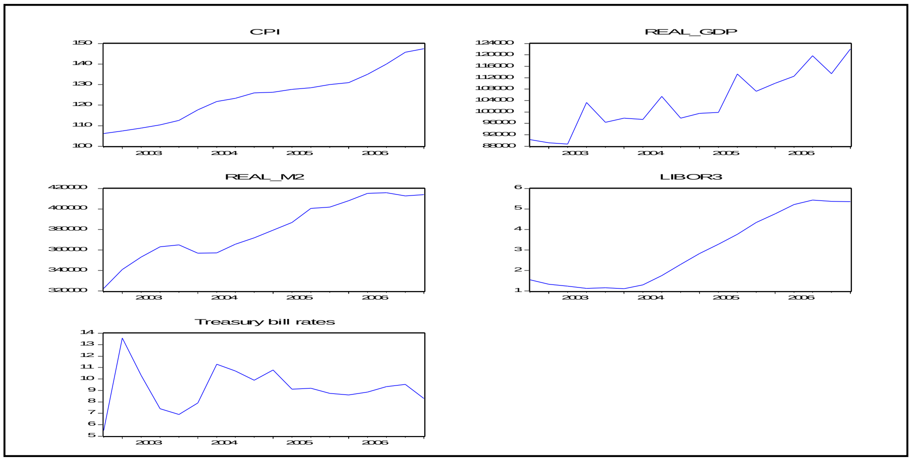


Table 26: The ADF unite root test on the TBs rates

Case	ADF Equation			ADF Test	
	β_0	β_1	λ	ADF statistic (t)	ADF Critical values
1	**0**	**0**	**-0.021**	-0.332	1% level -2.708094 5% level -1.962813 10% level -1.606129
2	**8.75**	**0**	**-0.96**	**-4.12**	1% level -3.920350 5% level -3.065585 10% level -2.673459
3	**8.8**	**-0.027**	**-0.92**	**-2.609**	1% level -4.728363 5% level -3.759743 10% level -3.324976

Table 27: The ADF unite root test on Δ^2 CPI

Case	ADF Equation			ADF Test	
	β_0	β_1	λ	ADF statistic (t)	ADF Critical values
1	**0**	**0**	**-1.21**	-3.852	1% level -2.728252 5% level -1.966270 10% level -1.605026
2	**0.094**	**0**	**-1.22**	**-3.68**	1% level -3.959148 5% level -3.081002 10% level -2.681330
3	**0.5**	**-0.04**	**-1.2**	**-3.447**	1% level -4.728363 5% level -3.759743 10% level -3.324976

Table 28: The ADF unite root test on Δ^2 LIBOR

Case	ADF Equation			ADF Test	
	β_0	β_1	λ	ADF statistic (t)	ADF Critical values
1	**0**	**0**	**-0.785**	-3.07	1% level -2.728252 5% level -1.966270 10% level -1.605026
2	**0.003**	**0**	**-0.786**	**-2.96**	1% level -3.959148 5% level -3.081002 10% level -2.681330
3	**0.795**	**-0.06**	**-2.576**	**-4.416**	1% level -4.992279 5% level -3.875302 10% level -3.388330

Table 29: The ADF unite root test on Δ Ln (M2/P)

Case	ADF Equation			ADF Test	
	β_0	β_1	λ	ADF statistic (t)	ADF Critical values
1	**0**	**0**	**-0.435**	-2.9	1% level -2.717511 5% level -1.964418 10% level -1.605603
2	**0.006**	**0**	**-0.59**	**-3.07**	1% level -3.920350 5% level -3.065585 10% level -2.673459
3	**0.008**	**-0.0002**	**-0.61**	**-2.82**	1% level -4.667883 5% level -3.733200 10% level -3.310349

Table 30: The PP unite root test on Δ RGDP

Case	PP Equation			PP Test	
	β_0	β_1	λ	PP statistic (t)	PP Critical values
1	**0**	**0**	**-1.51**	-6.52	1% level -2.717511 5% level -1.964418 10% level -1.605603
2	**2923.6**	**0**	**-1.6**	**-17.14**	1% level -3.920350 5% level -3.065585 10% level -2.673459
3	**2489.3**	**45.6**	**-1.6**	**-16.44**	1% level -4.667883 5% level -3.733200 10% level -3.310349

Table 31: The estimation results of regression 3.4

Dependent Variable: LN_REAL_M2				
Method: Least Squares				
Sample (adjusted): 2003Q2 2007Q1				
Included observations: 16 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	12.20025	0.084187	144.9184	0.0000
REAL_GDP	6.37E-06	8.59E-07	7.415656	0.0000
DIF_LIBOR3	0.029577	0.029741	0.994501	0.3396
LAGGED_DIF_CPI	-0.007417	0.004880	-1.519817	0.1545
R-squared	0.848035	Mean dependent var		12.86030
Adjusted R-squared	0.810044	S.D. dependent var		0.062015
S.E. of regression	0.027029	Akaike info criterion		-4.171516
Sum squared resid	0.008767	Schwarz criterion		-3.978368

Log likelihood	37.37213	F-statistic	22.32183
Durbin-Watson stat	2.210105	Prob(F-statistic)	0.000034

Figure 7: The stationary behavior of the residuals in regression 3.4

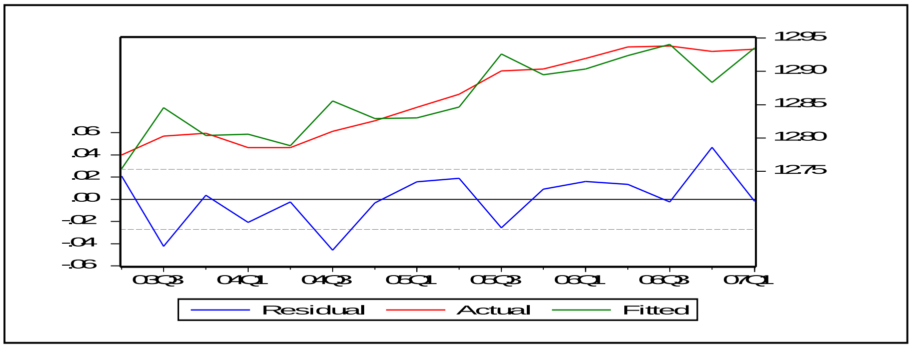


Table 32: Johansen cointegration test of regression 3.4

Sample (adjusted): 2003Q4 2007Q1				
Included observations: 14 after adjustments				
Trend assumption: Linear deterministic trend				
Series: LN_REAL_M2, REAL_GDP, DIF_LIBOR3, LAGGED_DIF_CPI				
Lags interval (in first differences): 1 to 1				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.937400	70.54408	47.85613	0.0001
At most 1 *	0.740522	31.75018	29.79707	0.0294
At most 2	0.548711	12.86299	15.49471	0.1199
At most 3	0.115858	1.723926	3.841466	0.1892
Trace test indicates 2 cointegrating eqn(s) at the 0.05 level				

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.937400	38.79390	27.58434	0.0012
At most 1	0.740522	18.88719	21.13162	0.1002
At most 2	0.548711	11.13906	14.26460	0.1474
At most 3	0.115858	1.723926	3.841466	0.1892
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

Table 33: Chow Breakpoint Test

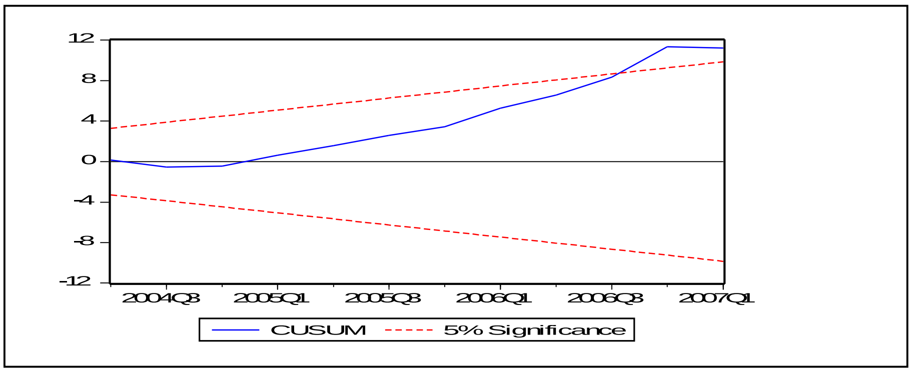
Chow Breakpoint Test: 2005Q1				
F-statistic	11.75096	Prob. F(4,8)		0.001977
Log likelihood ratio	30.84738	Prob. Chi-Square(4)		0.000003

Table 34: Chow Forecast Test

Chow Forecast Test: Forecast from 2005Q1 to 2007Q1				
F-statistic	13.30485	Prob. F(9,3)		0.028165
Log likelihood ratio	59.38377	Prob. Chi-Square(9)		0.000000
Test Equation:				
Dependent Variable: LN_REAL_M2				
Method: Least Squares				
Sample: 2003Q2 2004Q4				
Included observations: 7				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	12.65095	0.068453	184.8120	0.0000
REAL_GDP	1.60E-06	7.16E-07	2.242162	0.1107
DIF_LIBOR3	0.049449	0.014484	3.414122	0.0420

LAGGED_DIF_CPI	-0.006766	0.002495	-2.711460	0.0731
R-squared	0.886436	Mean dependent var		12.79879
Adjusted R-squared	0.772872	S.D. dependent var		0.017733
S.E. of regression	0.008451	Akaike info criterion		-6.413466
Sum squared resid	0.000214	Schwarz criterion		-6.444374
Log likelihood	26.44713	F-statistic		7.805598
Durbin-Watson stat	2.769337	Prob(F-statistic)		0.062709

Figure 8: Recursive residuals of equation 3.4



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